DOCUMENT RESUME

ED 318 409 IR 014 313

AUTHOR Felker, Alex D.
TITLE Broadcast HDTV Standards and Spectrum Tradeoffs. High Definition Television.
PUB DATE Oct 89
NOTE 27p.; Paper presented at the Annual Telecommunications Policy Research Conference (17th, Airlie House, Warrenton, VA, October 1-3, 1989). For other papers of this conference, see IR 014 305-322.
PUB TYPE Historical Materials (060) -- Viewpoints (120) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Broadcast Industry; *Broadcast Television; *Federal Regulation; Policy Formation; *Standards; *Telecommunications
IDENTIFIERS Federal Communications Commission; *High Definition Television; Regulatory Agencies

ABSTRACT

This paper opens with a brief discussion of what some have seen as an unusual threshold decision by the Federal Communications Commission (FCC) to establish a broadcast high definition television (HDTV) system. It then identifies the spectrum and standards tradeoffs which are posed by the establishment of a HDTV broadcast transmission standard, and discusses the approach the FCC has taken in addressing the technical and policy issues involved. The argument is presented that the FCC must make hard choices in that spectrum must be allocated and assigned, and standards must be chosen. The difficult aspect of these choices--and the thing that makes them interesting to policy analysts--is that there is unlikely to be only one set of "right answers" emerging from the debate, although only one of many good solutions may be best for consumers. The paper concludes with the warning that, although the temptation to hold off making final judgments in these matters is likely to be strong, delay could prove costly to both consumers and firms. (GL)

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BROADCAST HDTV STANDARDS AND SPECTRUM TRADEOFFS

Alex D. Felker[1]

No communications policy issue in the past two decades has captured the imagination of legislators, regulators and the popular press to the degree that high definition television has. Whether the benefits of this new set of technologies are worthy of the attention they are receiving is a topic for another paper. What is clear, however, is that the establishment of HDTV -- especially for terrestrial broadcast -- is a multifaceted problem with many pitfalls for government decision makers.

The topic of high definition television can conjure up different issues to different people. It is frequently touted as a way of improving US competitiveness by providing the means and the incentive necessary to rebuild the American consumer electronics industry. Such a result, it is argued, could produce both commercial and national security benefits. Others have seen the development of a high definition production standard as

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1 Formerly Chief, Mass Media Bureau, Federal Communications Commission. The views expressed in this paper are those of the author and do not necessarily reflect the views of the FCC or any Commissioner.

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resolving the technical incompatibilities among the world's television systems thereby improving the opportunity for program exchange.

For policy analysts, the HDTV debate presents a opportunity to study the process by which interrelated technical and economic factors are weighed and judgments are reached. In the establishment of what has been referred to as the next generation of television, it is becoming increasingly clear that there will be both winners and losers, and regulators will have an extremely difficult job in identifying, from a number of apparently good alternatives, the decision which is best for consumers.

In this paper no attempt is made to examine all aspects of HDTV policy making. Rather, attention is focused solely on the matter of establishing a broadcast (terrestrial) HDTV transmission standard. Although the scope is somewhat narrow, a large number of knotty policy and technical problems are still presented. This paper identifies the spectrum and standards tradeoffs which are posed by the establishment of a HDTV broadcast transmission standard and examines the approach the FCC has taken in addressing these issues.

The paper opens with a brief discussion of what some have seen as an unusual threshold decision by the FCC to establish a broadcast HDTV system. This is followed by a recitation of the development of HDTV policies by the FCC. The paper then turns to a development of the technical and policy issues presented by the establishment of a broadcast HDTV standard -- especially those related to standards and spectrum -- which are at the

heart of the FCC's work in this area. The paper closes with some concluding observations.

I. Why Establish a Terrestrial Broadcast HDTV Service?

The efforts of the Federal Communications Commission (FCC) to develop what it calls advanced television (ATV) technologies have focused primarily on establishing a terrestrial broadcast standard.[2] This approach is logical in that there exists a substantial constraint on the amount of spectrum capacity available to deliver the significantly greater amounts of information contained in HDTV signals terrestrially, and the Commission has statutory authority to allocate spectrum and make related decisions (e.g., establish transmission standards).

The U.S. is unique among all nations in its pursuit of a terrestrial HDTV system, however. Other countries have not elected to follow this course for a variety of reasons, but the most important is the lack of available spectrum capacity. The Commission's decision to engage the question of broadcast HDTV is based on both political and public policy

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2 The Commission has elected to study all forms of improved image technologies, from enhancements of the present NTSC (National Television Systems Committee) television standard to systems whose quality approaches that of 35 mm film (roughly twice the resolution of NTSC). All of these technologies are referred to collectively by the Commission as "advanced" television (ATV). Although it is recognized as being somewhat inaccurate, in hopes of avoiding confusion, the term "HDTV" is used throughout this paper without regard for the precise degree of quality improvement being contemplated.

considerations. TV broadcasters, as a group, have been an extremely active and agressive force in the HDTV policy debate and will not allow themselves to be summarily cut out of the next generation of television. In fact, it was a large group of broadcasters that generated the political and regulatory interest necessary to initiate the Commission's first Notice of Inquiry.[3]

Beyond the political pressure generated by broadcasters, however, there are good public policy reasons for the Commission to concentrate its efforts on establishing a broadcast HDTV system. As an initial matter, reports of broadcast television's death have been greatly exaggerated. While it is true that upwards of 55% of TV households now subscribe to cable, it is also obvious that more than 45% of households do not. Thus, there are

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3 Many observers in and outside of the Commission believed at the time that the broadcaster effort was motivated primarily by a desire to derail a pending proceeding to reallocate some UHF television spectrum to various land mobile services (see, note 13, below). If such was in fact the motivation, the plan may have backfired a bit on broadcasters. While non-broadcast HDTV poses a competitive threat to broadcasters, at the time such a threat was more theoretical than real because the cable industry was uninterested in introducing radical changes in the near term and consumer interest was nil. Hence, probably few of the broadcasters that signed the original petition actually anticipated making the significant outlays necessary to convert their plant to HDTV in the near term. Largely as a result of interest stimulated by the Notice of Inquiry and subsequent events, however, today consumer and cable interest in HDTV is substantially greater. In the long run, cable competition may have a much larger effect on broadcaster profits than land mobile services. To respond to that competition, it now seems likely that, within the next several years, many broadcasters will be forced to spend millions of dollars to upgrade their facilities to maintain technical parity with their cable competitors. (See, note, 23, below).

literally millions of viewers that obtain their video exclusively from broadcast stations. Of perhaps even greater significance is the fact that even in cable homes a substantial majority of viewing (65%) is devoted to broadcast television stations. Although new distribution technologies will undoubtedly eat into broadcast TV's market share over the next decade or two, broadcast television will continue to be a leading source of video programming for all Americans. The success of new video formats will almost surely be enhanced by the accomodation of broadcast TV.

Furthermore, at almost any practical level of absolute channel capacity, bandwidth is also scarce for cable operators and is likely to remain so for the foreseeable future. Therefore, although motivated by economic considerations rather than government regulation, in selecting an HDTV transmission standard cable operators will face a spectrum constraint very similar to that faced by broadcasters. Thus, there is a natural area of common interest between the broadcast and cable industries, and it seems likely that the establishment of a broadcast system will profoundly influence the development of a system for cable TV.[4]

In sum, the Commission's decision to develop broadcast HDTV may produce significant benefits for viewers, broadcasters, and others engaged in the production and distribution of video programming. The amount of net

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4 Nevertheless, as I suggest later, the absence of a mandated cable TV HDTV standard should held reduce any downside associated with the Commission's selection of a broadcast standard.

benefits to society, however, will depend on how well the various tradeoffs are managed. Any spectrum allocation to HDTV, for example, will reduce the amount available for other productive communications services (e.g., cellular telephone). Moreover, the HDTV's utlimate value will depend on how well the development of a transmission standard balances image quality improvements against equipment costs. Before engaging in a discussion of these tradeoffs, the regulatory events which have transpired to date are summarized briefly.

II. Regulatory History

Although it has only recently achieved national attention, the idea of substantially improving on the quality of electronic images is something that engineers and scientists have been wrestling with in one form or another for decades. At the international level, negotiations on a world wide production standard have been underway throughout most of this decade, with FCC staff participating as advisors to the Department of State.

The Commission became formally involved in the emerging HDTV debate in 1987. In response to a petition filed by scores of broadcast licensees and associations, the Commission initiated a wide ranging inquiry to consider the technical and public policy issues surrounding the use of improved

television technologies by broadcast licensees.[5] At about the same time, the FCC also established the Advisory Committee on Advanced Television Systems to assist it in identifying and analyzing the issues posed by HDTV.[6] The Advisory Committee has operated in parallel with the FCC and has produced documents which have formed the foundation of Commission action.

The Commission began its proceeding with a clean slate. It expressed no preconceived notions as to the form HDTV should take or even whether the

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5 See, Advanced Television Systems, Notice of Inquiry MM Docket 87-268, 2 FCC Rcd 5125 (1987).

6 The parent Committee (the so called "Blue Ribbon" panel) is composed of 25 voting members representing most of the leading firms in the broadcast, cable and consumer electronics industry and is chaired by former FCC Chairman Richard Wiley. This group oversees the work of various subcommittees, working parties and advisory groups. The Advisory Committee has produced three reports whose findings, conclusions and recommendations are generally based on the scores of documents produced at the working level.

The Advisory Committee was originally envisioned as a forum through which most of the industry participants affected by decisions in this matter could experience the pain and agony the Commission would bear in rendering a judgment. It was believed that this pain sharing would facilitate the formation of the consensus necessary for the Committee's recommendations (and ultimately the Commission's decision) to stick. What was not forseen was either the level of effort at which the various industries would participate in the Advisory Committee process or the quality of work produced by this group. It has been estimated that to date upwards of 500 skilled professionals have participated in the workings of the Advisory Committee, and the depth and scope of the information developed by this group is enormous. Moreover, the Committee process has spawned the formation of other establishments to work in concert with the Committee. The most notable of these enterprises are the Advanced Television Test Center (ATTC, formed by a group of broadcasters, networks and trade associations) and the Cable Labs (established by a group of cable MSOs). It is anticipated that over the next two years or so these two concerns will perform the bulk of the objective, subjective and field tests which the Advisory Committee has planned.

establishment of a new generation of television was in the public interest. It did announce, however, that it intended to reach judgments on this matter as expeditiously as possible. In keeping with this goal, the Commission indicated its intention, as circumstances warranted, to narrow the range of options available. The Commission reasoned that by converging on a set of solutions in an orderly fashion, design engineers would not waste their efforts on system architectures which had little likelihood of being endorsed by the FCC.

In September of 1988 the Commission adopted a document which set forth both a series of tentative conclusions to guide further developmental work and an additional notice of inquiry.[7] In addition to making a threshold determination that broadcast HDTV would serve the public interest, in this document the Commission also announced its intention not to allocate any additonal frequency bands for use by this service and to limit additional frequency assignments to a maximum of 6 MHz per broadcast station. The Commission also expressed both a desire to maintain service to existing television receivers and a disinclination to take any action to retard the introduction of HDTV on non-broadcast media.

In addition to detailing the set of tentative conclusions summarized above, the Further Notice began to explore in some depth issues regarding

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7 See, Advanced Television Systems, Tentative Decision and Further Notice of Inquiry, MM Docket 87-268, 3 FCC Rcd 6520 (1988) (Further Notice).

spectrum use and assignment and transmission standards. These, and other, issues are considered in the following section.

III. Spectrum and Standards Tradeoffs

In some ideal sense, it might be desirable if the Commission mathematically modeled an objective function, and, using operations research methodology, solved for the "optimum" broadcast HDTV standard (i.e., the one which had the largest net value). In practice, of course, regulations are never developed using such a process. This is true both because of the inherent difficulty regulators have in accurately quantifying costs and benefits and because of the many equity factors not related to efficiency which regulators must inevitably consider in fashioning a regulatory solution that is politically acceptable.

Nevertheless, the best regulatory decisions are those which are informed as to the tradeoffs which are presented. In this section, attention is given to the most significant HDTV cost and value factors, the practical and policy constraints are identified, and the FCC's approach to addressing them is examined.

A. Spectrum Issues

Studio-produced HDTV images and audio signals contain over five times as much information as a corresponding NTSC signal. Inasmuch as there is a functional relationship between the minimum bandwidth required of a channel

and the amount of information which can be conveyed over it, significant quality improvements will undoubtedly require bandwidth assignments larger than the 6 MHz NTSC channels.[8] Therefore, in developing HDTV policies, the FCC will face questions of efficient resource allocation, among uses and users.

Exactly how much more spectrum capacity will be necessary for each station wishing to engage in HDTV broadcasting is a function of both the level of quality delivered and the complexity of the encoding and decoding equipment employed. The greater the spectrum capacity of the channel, the higher the quality and/or the lower the equipment complexity (and cost). Thus, absent any opportunity costs which could arise from employing spectrum in alternative uses, the tendency would be to allocate a substantial amount of additional spectrum capacity for HDTV.

Choosing Among Communications Uses. Of course, the spectrum opportunity costs are far from zero. For a variety of practical technical reasons, terrestrial broadcast services are best realizable on frequencies below about 13 GHz, and most broadcast system engineers express a strong

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8 Although an NTSC signal has a nominal bandwidth of 6 MHz, for every TV assignment a much larger amount of frequency space must remain unused in a given location due to the relatively poor interference performance of television receivers. Interference between adjacent channel VHF TV stations, for example, is controlled by separating transmitters by at least 60 miles. UHF stations must comply with as many as 18 off-channel assignment restrictions known as the "UHF taboos." See, 47 U.S.C. Section 73.689 Table II.

preference for frequencies below about 1 GHZ. Demand for access to this range of frequencies is very heavy. Essentially all of these frequencies are already allocated and assigned for government and private communications systems.[9] Thus, the prospects are dim for identifying vacant or otherwise unwanted allocations, outside the existing VHF and UHF TV bands, that could be earmarked for HDTV.

The FCC has tentatively decided not to reallocate spectrum from other services to HDTV, thereby implicitly concluding that the gains of broadcast HDTV operation on these frequencies do not outweigh the cost of displacing than those services for which the frequencies are already allocated.[10] The effect of this decision will be considered to a greater extent later, but

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9 Spectrum management is frequently described as being composed of three activities: allocations, allotments and assignments. These terms describe, respectively: defining the uses to which bands of spectrum will be employed; earmarking channels for use in a particular geographic locale; and granting to a particular firm or the authority to operate a communications system on a particular channel. For a greater description of the Commission's spectrum management process, see, "Spectrum Management Policy in the United States: An Historical Account," John O. Robinson, OPP Working Paper No. 15 (FCC) (1985).

10 There has been some Congressional interest in freeing up spectrum now allocated to the federal government for use in commercial endeavors, including HDTV. The Chairman of the House Commerce Committee, John Dingell has drafted legislation which would require NTIA to identify some 200 MHz of federal government capacity, between 30 MHz and 5 GHz, which could be shifted to the private sector. At this juncture, the success of this legislation is uncertain, and in any event the reallocation schedule could be as long as ten years. Therefore, it seems unlikely that spectrum freed up through this activity could be used for HDTV, at least for the forseeable future. Nevertheless, if a substantial amount of additional capacity did ultimately become available, it would help reduce any efficiency losses which might result from allocating too much spectrum for HDTV.

by limiting the amount of spectrum capacity available for HDTV to that already allocated for broadcast television, the Commission has capped the combination of broadcast HDTV quality, station coverage, and the number of HDTV stations to some maximum.

Fortunately, because of the assignment "taboos" the FCC has employed in authorizing UHF television service, a substantial number of UHF channels remain vacant -- even in major markets, and the Commission has made clear its intention to use these channels for HDTV, if necessary. Opportunity costs exist in using even the taboo channels for HDTV because much of this vacant television spectrum could be used productively in a variety of other communications activities. Some channels could be readily employed by full service or low power NTSC television facilities (LPTV), for example.[11] In addition, land mobile and cellular telephone services, which are already using nearby frequencies, could feasibly use these channels.[12] From time to time other suggestions have also been made of services (e.g., wireless cameras, studio-transmitter links, and multi-channel broadcast digital

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11 In recognition of the potential conflict, the Commission "froze" acceptance of any applications for new TV stations and any petitions for new TV allotments within 150 miles of the top 30 markets. New LPTV applications were not frozen, but the secondary status of these licenses make them subject to displacement if the capacity is needed by a full service station.

12 These frequencies were reallocated from TV in the early 1970's. In 1985, the Commission again proposed reallocating several UHF TV channels in eight urban areas to the land mobile services. See, Notice of Proposed Rulemaking in GEN Docket 85-172, 50 FR 25,587 (June 20, 1985). The Commission has deferred further action in this proceeding pending an assessment of HDTV spectrum requirements.

audio) that could utilize the UHF taboo channels productively.

While the Commission's primary intent is to utilize available capacity in the TV bands for HDTV, the agency is also aware of the potential public interest benefits other uses of these frequencies could produce. In this regard, it has sought comment on the desirability and feasibility of a plan to permit the frequencies set aside for HDTV to be used for other purposes, at least during the transition period to HDTV.

Regardless of which standard is established, the large costs involved in re-equipping a television will probably discourage some licensees from deploying HDTV for many years after a standard is adopted. Rather than having them lie fallow during this period, the Further Notice suggested allowing licensees to use the HDTV channels assigned to them in other productive endeavors. The scheme offers two potential advantages. Importantly, consumers would stand to gain from the benefits flowing from the communications services deployed on these otherwise unused frequencies, and under some circumstances these benefits may be substantial. Moreover, broadcasters could use the profits derived from the use of these frequencies to underwrite what most observers see as a potentially expensive switch from NTSC to HDTV.

Obviously such an unconventional idea poses some practical and public policy questions, which were detailed by many commenters to the Further Notice. The two biggest commenter worries involved the Commission's legal authority to implement the plan (and whether it might be extended to other

situations) and whether such "temporary" alternative uses would in actuality be permanent.

Choosing Among Users. Even absent the demands of other services, spectrum capacity for HDTV is going to be scarce, especially in the major markets.[13] The demand for and supply of spectrum capacity will be further affected by two Commission policy cuts. The first is the FCC's continuing goal to provide every broadcaster wishing to deliver HDTV with an opportunity to do so.[14] The Commission has also tentatively concluded that, regardless of the system ultimately selected, service to existing NTSC receivers will be continued, at least for some transition period. The tradeoffs presented by these policy decisions are considered below.

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13 Spectrum capacity in the broadcast auxiliary bands is already in short supply due to increasing broadcaster demand for ENG and STL channels. While the FCC has acknowledged that HDTV could exacerbate the congestion on feeder links, and the Advisory Committee is studying ways of addressing the problem, the ready availability of substitute capacity (from common carriers, for example) might reduce the need for the FCC to reallocate additional spectrum capacity exclusively for HDTV feeder services.

14 In the Further Notice the Commission suggested that there were strong public interest arguments to support its proposal to limit eligibility for HDTV assignments to existing broadcasters. It, therefore, implicitly rejected the option of establishing a completely new HDTV service with application open to all statutorily qualified parties. Nevertheless, it may be that the Ashbaker doctrine would require acceptance of applications from a much broader group of parties. (See, Ashbacker Radio Corp. v. FCC 326 U.S. 327 (1945)). It is likely that the HDTV standard ultimately adopted by the Commission will be strongly influenced by the Commission's legal ability to abide by its tentative judgment in this area, and whether the Courts concur on appeal.

To even approach achieving the goal of providing all existing broadcasters with an opportunity to deliver HDTV,[15] stringent limits will be required on the assignment of additional frequencies. The FCC has recognized this, and, in its Further Notice, the agency tentatively decided to limit additional spectrum assignments to a maximum of 6 MHz. In addition to the bandwidth limitations, the capacity of these assignments will have to be further limited by maintaining HDTV transmitters at low power levels.

The Commission further reduced both the supply of spectrum and design engineers' creative flexibility by requiring the maintenance of TV service to existing NTSC receivers. This decision has been the least controversial of the agency's public policy constraints, perhaps because it was seen by many as more an acknowldgement of reality rather than a decision founded on the delicate balancing of competing interests. But, together with the

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15 Spectrum studies by the FCC and the Advisory Committee indicate that, as a theoretical matter, between 95 and 99 percent of all existing television stations could be assigned an additional 3 or 6 MHz. But, these assignment percentages are predicated upon elimination of any assignment taboos and co-channel transmitter spacings of 100 miles -- less than half the present spacing. An HDTV transmission system must, therefore, be virtually transparent to NTSC reception and extremely robust in the face of noise and other electronic signals; a challenging design task even when bandwidth and cost are not significant constraints. In reality, it seems almost certain that fewer assignments will be available than predicted because some taboo restrictions will remain. In addition, the power/interference constraints posed by 100 mile co-channel spacings will surely result in HDTV coverages that are smaller than NTSC.

limitation on spectrum capacity, the "compatibility" constraint has already had an effect on the design of proponent systems.[16]

The most visible sign of the effect of these various constraints was the elimination of MUSE-E from further consideration as a U.S. broadcast standard.[17] MUSE-E was, and is, the only system HDTV transmission standard in the world that has progressed beyond a prototype stage. It is now being used in satellite transmissions beamed daily to some viewers in Japan. Full service is expected to commence in early 1991. But it was designed for the wider bandwidths of satellite systems, and it will simply not "fit" into the spectrum scheme envisioned by the FCC. The Commission's action has encouraged the design of 6 MHz "simulcast" transmission schemes, however, and several proponents are working on this form of HDTV system.[18]

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16 Although this policy has frequently been referred to as a "compatibility" requirement, systems may comply in one of two ways: 1) by being directly compatible with NTSC receivers (as color is to monochrome); or, 2) by operating an NTSC transmission in tandem with an incompatible HDTV transmission (the so-called "simulcast" method). Both system types are being developed.

17 NHK, the firm which developed MUSE-E, has wasted no time in redesinging its system to make it consistent with the Commission's tentative conclusions, however. Three additional MUSE-based systems (affectionately referred to as the "MUSE-ettes") are in various stages of development. If they perform as anticipated, they would be serious contenders.

18 In addition to simulcast systems, the Commission described two other categories of proponent systems in its Further Notice: enhanced systems which improve the quality of the existing NTSC signal but utilize only the present 6 MHz channel; and augmentation systems which deliver improved resolution information on a separate 3 MHz or 6 MHz channel which combine with an existing NTSC signal to produce a higher quality display.

Despite the emergence of innovative system architectures which make intensive use of spectrum capacity, the FCC's spectrum supply and demand decisions will limit HDTV coverage and quality. The extent of these limiations is not yet known, but the very difficult engineering problems that must be overcome should not be underestimated. Even if a viable system will operate within the capacity limitations, in some large markets demand for spectrum capacity could still outstrip supply. The FCC has recognized this possibility and has sought comment on ways of choosing among competing applicants in such cases, including using comparative hearings and lotteries. Commenters generally urged the FCC to endeavor to identify sufficient spectrum so as to avoid the problem of choosing among applicants. Absent this solution, commenters generally favor an expedited hearing approach.

Another procedure for assigning scarce spectrum capacity has also been advanced. It would not involve the FCC in the selection process as intimately. Under this approach, the spectrum capacity available in each market would be divided up uniformly so that each licensee would be assigned a more-or-less equal amount. Licensees would then be encouraged to work together to assemble a smaller number of larger capacity packages from the spectrum "pieces" assigned initially. All such private agreements would be subject to Commission approval following opportunity for public comment.

There are two potential advantages in adopting this sort of "licensee self-selection" mechanism. First, the Commission would be able to avoid most of the delay associated with other schemes and their anticipated legal

challenges. In the event that final transmission standards decisions may be deferred pending the outcome of such challenges, the cost of delay could be substantial.

There is also a higher probability of achieving an efficient set of assignments in all markets if this scheme were employed. Parties which value the HDTV spectrum capacity the greatest, and which intend to institute service most quickly, would seem to have a far greater chance of quickly securing the needed capacity by striking mutually beneficial arrangements with other licensees than through a more formal administrative process.

As was true for the novel allocation proposal discussed earlier, however, commenters have not enthusiastically endorsed this approach for addressing the efficiency, equity and legal issues which could arise in the context of assigning broadcasters additional spectrum capacity. Clearly, there are tough practical problems that require resolution before such a plan could be affected, and obviously if sufficient capacity exists to assign all licensees an adequate amount there is no need to implement any type of selection scheme. The Advisory Committee is currently studying this and other possible spectrum assignments through its Implementation Subcommittee.

B. Standards Issues

The optimum HDTV transmission standard is one in which, within the relevant practical, policy and political constraints, the net difference between the value of quality improvements and costs of spectrum use and equipment complexity is maximized. Spectrum costs were considered in the previous section. In this section, other tradeoffs which are presented in considering a standard are examined.[19]

The FCC and HDTV Standards. Well defined compatibility standards can help reduce any inertia which is present to the introduction of a new communications service, such as HDTV. The assurance of technical compatibility acts to reduce the risk of investment for audiences, equipment manufacturers and broadcasters. On the other hand, technical standards can also tend to lock-in an unwanted or outdated technology. Especially in an area where technical advancements are coming rapidly, such as high definition television, regulators should act cautiously in instituting technical standards.

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19 There are really two different ongoing standards debates. One involves so-called "production" standards, i.e., standards to govern studio equipment. The main forum for this debate is the CCIR, with Japan and the European Community each pushing for acceptance of the design they have developed as the single, world-wide HDTV production standard. While there is some relationship between production and transmission standards, the US (and the FCC) have attempted to address the two separately.

In this particular case, all the parties to the proceeding have taken the position that the public interest would best be served if the FCC established a manadatory HDTV transmission standard. The Commission has stated repeatedly that it has every intention of selecting a single broadcast transmission standard.[20]

Nevertheless, the agency has also expressed an interest in exploring ways of hedging against selection of the "wrong" standard and providing a path for new technologies to be adopted, when and if appropriate. Three possible approaches were outlined in the Further Notice: limiting the duration of the standard; protecting one standard from interference but not requiring its use; and, adopting a standard for allocation and assignment purposes only.

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20 Until relatively recently, the Commission has routinely established very detailed broadcast compatibility standards. Over the past ten years or so, however, because of an increased awareness of the potential downsides of mandated technical standards, the agency has exhibited some reluctance in setting detailed technical standards. The most celebrated example of this reluctance is the case of AM stereo standards. Here, the Commission adopted manadatory standards only to be heavily criticized for choosing the "wrong" one. After a great deal of further staff analysis and additional public comment, the agency ultimately concluded that there was no defensible rationale upon which to adopt a standard, and returned consideration of the matter to "the marketplace." Rightly or wrongly, many observers attribute the weak penetration of AM stereo, and the general decline of AM listenership, to this one non-decision. A rigorous treatment of the economics of this, and other communications standards, can be found in, Besen, Stanley M. and Garth Saloner, "Compatibility Standards and the Market for Telecommunications Services," (February 1988).

Conceptually, parties generally favored providing a means for introducing technological advancements. None of the ideas advanced by the Commission received much favorable comment, however. The issue continues to be discussed, and recently the Advisory Committee has begun considering the feasibility of incorporating into an HDTV standard sufficient "headroom" to accommodate technological advancements. The hope is that a new standard could be at least as flexible in accommodating new techniques as NTSC. Although it has been refined and improved many times over the past 50 years, today's NTSC is still based on its original characteristics. This an extremely difficult issue to come to grips with, however. NTSC headroom was developed more by the accident of technological advancement than by design. In the present context, what is meant by "headroom," and how should it be accomodated, has yet to be established.

Although it did not consciously set out to do so, the Commission's decision to focus on a broadcast standard, while refraining from taking any action that would retard the introduction of HDTV on non-broadcast media, might provide another possible path for introducing new and better video transmission formats.[21] As was mentioned earlier, there are economic incentives which encourage non-broadcast media to adopt HDTV transmission

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21 In arriving at this tentative finding, the Commission observed that cross-media compatibility has already been achieved without direct governmental intervention and theorized that sufficient economic pressures would exist to virtually eliminate any chance that a destructive de facto standard will emerge. It reasoned, therefore, that there was no need to engage the question of non-broadcast standards, at least immediately.

standards which are the same as, or similar to, the broadcast standard. But these forces are not absolute, and if technical quality is an important determinent of market share, then operators of non-broadcast media will have an incentive to introduce higher quality formats if and when they become cost-effective. There are a couple of factors reasons to believe that these operators might be more willing than broadcasters to take a chance on a higher quality but incompatible HDTV system sometime in the future.

First, most non-broadcast systems are already using transmission formats that differ from NTSC in some fashion. These signals are converted to NTSC at the subscriber terminal and then interface directly with television receivers and monitors. As a result of this system architecture, these media may be better positioned technically than broadcasters to introduce new formats quickly.

In addition, the multi-channel media may face lower risks in introducing new formats both because of the ability to do so selectively (perhaps only for pay channels) and because of the possibility of cost-sharing with program producers. Thus, their investment decisions need not be of the all-or-nothing variety.

The chance that non-broadcast operators might someday introduce an HDTV system of higher quality than a broadcast system is no reason for constraining them to the broadcast standard. The economic forces on non-broadcast operators to adhere to the broadcast standard are strong, and there is no reason to believe that, in the shortterm there is any risk of a

de facto standard emerging. But for the long term, so long as these media are not constrained by a government-mandated compatibility standard, they will have both the means and incentive to introduce new or refined formats if they provide greater value to viewers. Such an arrangement increases the likelihood of achieving an efficient standard in the long run.

Assessing the Value of Quality. Whether the benefit to viewers of HDTV will exceed the spectrum and equipment costs is unknown.[22] Certainly in the minds of some observers there is a real question as to what will be the ultimate demand for HDTV.[23] And even the most bullish HDTV supporters express some concern as to how quickly Americans will accept the large screen receivers necessary to obtain the greatest enjoyment from HDTV.

Nevertheless, as most people who have viewed it testify, watching wideband HDTV on a large screen is a fundamentally different viewing (and, with digital sound, listening) experience than NTSC. All things being equal, and assuming "reasonable" prices, it is hard to imagine American viewers would not jump for it if given the opportunity. It is predicted

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22 For viewers, costs differences among the various systems are probably not too large. The least complex systems (probably an enhanced form of NTSC) will probably have the smallest receiver cost premium, and the most complex will probably have the largest. For broadcasters, however, the cost differential between the two categories described above appears to be an order of magnitude. Regardless of the system selected, broadcasters should not be surprised if equipment and labor costs associated with moving to a new transmission standard run into the tens of millions of dollars.

23 See, "Audience Doesn't See HDTV as 'Revolutionary New Medium,' Studies Show," Communications Daily, vol. 8, no. 72 (April 14, 1988).

that some time in the forseeable future low power, inexpensive flat screen displays will be developed for consumer application. At that time consumer acceptance of HDTV receivers may really take off, especially if new software and services are developed which take maximum advantage of the high resolutions available.[24]

At this time, however, how viewers will rank HDTV attributes, both in relative and absolute terms, remains unknown. Information on this aspect of the various proponent designs will be a crucial input to standards deliberations, and the Advisory Committee is planning an extensive testing effort to quantify the subjective aspects of picture quality.

IV. Concluding Observations

The Commission has embarked on an ambitious course to establish the next generation of television technology. Despite the fact that the issue implies potentially significant competitive ramifications for the entire video industry, uncertainty remains as to the demand for HDTV, and whether its benefits exceeds its costs. Moreover, the related spectrum allocation issues are extremely important because of the wide-ranging communications

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24 Some analysts believe HDTV has the best chance of achieving consumer acceptance if it is coupled with a new dimension in viewing, such as might be possible through highly sophisticated two-way types of services. These service will probably only be provided via a fiber optic communications network. See, "Bellcore VP says HDTV Won't Justify Telco Installation of Fiber," Communications Daily, vol. 9, no. 183 (September 21, 1989).

opportunities which may be foregone as a result of the establishment of HDTV.

The most difficult tradeoffs to assess are those involving spectrum and standards. The Commission has attempted to converge upon a decision in these related areas by gradually narrowing the options as more information and analysis is developed. Because it identifies early in the process those characteristics which will disqualify contending systems, this approach has helped to minimize resource waste among proponents. Ultimately, however, hard choices must be made: spectrum must be allocated and assigned; standards must be chosen. The difficult aspect of these choices -- and the thing that makes them interesting to policy analysts -- is that there is unlikely to be only one set "right" answers emerging from the debate. It is far more likely that there will be many good solutions, but only one which is best for consumers.

To make its decision as sound as possible, the Commission has set out to develop a large amount of hard information. Through the Advisory Committee, a great deal of study has been, and will be, performed to quantify the technical, economic and subjective aspects of HDTV. To further reduce the downside inherent in reaching its judgments, the Commission has suggested a number of unusual regulatory devices. All of these more novel approaches would make use of affected parties' self interest as means of discovering an optimal balance between conflicting interests.

The initiation of broadcast HDTV is still many years off, and many opportunities for regulatory missteps remain. A finding that, because of the Ashbacker doctrine, the Commission could not limit eligibility to existing licensees if it adopted certain certain types of standards might pressure adoption of a suboptimum transmission format, for example. In addition, finding a transition which encourages early deployment of HDTV equipment will be difficult.

A potentially serious problem is regulatory inaction. The temptation to hold off making final judgments on these matters is likely to be strong. There will always appear to be some value in conducting one more study or providing an opportunity for one last system design to be developed. Broadcasters themselves may have an incentive to delay the final action as long as possible, if such action would appear to hold off competitive pressure and reduce transition costs.

But delay could prove costly to both consumers and firms. Any willingness by the FCC to delay could discourage the future funding of both proponents and the institutions upon which the Commission will rely during this proceeding. Delay might also disadvantage broadcasters if it permitted non-broadcast media to introduce HDTV much earlier. Finally, and perhaps most importantly, unnecessary delay would be costly to all consumers because it would idle spectrum capacity which could be employed productively in a variety of endeavors. While legitimate delays will undoubtedly occur, the FCC should continue on its course of providing for refinement and correction after the fact and resist attempts to needlessly drag the process out.